KNOWLEDGE
AN ILLUSTRATED
MAGAZINE OF SCIENCE
PLAINLY WORDED—EXACTLY DESCRIBED

LONDON: FRIDAY, JUNE 1, 1883.

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THE GREAT INTERNATIONAL FISHERIES EXHIBITION.

NATURAL HISTORY DEPARTMENTS.

By JOHN ERNEST ADY.

INTRODUCTORY.

THE Teutonic name *fisc*, allied to the Latin *piscis*, was originally applied indiscriminately to animals which live in water. It became necessary, however, in the development of scientific nomenclature, to restrict the meaning of the term, and *fish* came to signify, in popular zoology, an oviparous aquatic animal, provided with gills, covered with scales, and, most important of all, furnishing a vast tribe of animals with a staple diet. From the earliest historical records, we find that the value of fish as an article of food impelled man to devise plans for their capture; economy led the way, and pleasure followed in its wake, and thus arose, by degrees, the intricate arts of fishing, with their multitude of observances, which have even affected the laws of nations. Let us trace how these two factors, utility and amusement, have been represented in the valuable institution at South Kensington.

The casual visitor to the Exhibition will, perhaps, be bewildered with the extensive and varied collection which may meet his gaze, and ask—What has all this to do with fish and fishing? Here, an exquisite case, the property of Lady Brassey, resplendent with beautiful sponges, corals, and shells, is placed at the head of a short corridor near the fine art saloon at the principal entrance. The corridor ends in one direction in a cul-de-sac, at the termination of which a blue-jacket (sailor?) is stationed vending tracts. Let us suppose that the visitor is a student of natural science. He sees, from Lady Brassey's splendid collection, that fishing in its modern acceptation is not confined to the zoological order *Pisces*, but that the same economy which directed the fisher to the fish made him also a fisher of pearls and corals, wherewith to furnish the æsthetic tastes of his fellow-creatures with food, and delight their senses with beauteous forms and colours. Then, too, is not the blue-jacket a "fisher of men"?

To the right-hand side, this corridor continues in an easterly direction, and the student comes face to face with another beautiful cabinet, displaying a varied selection of knives, forks, etc., mounted in lobster claws; he is once more reminded that, beside molluscs, corals, and sponges, lobsters and their allies play some part in fisheries. Most appropriately, this case precedes a series of similar stalls, and the names, Crosse and Blackwell, in their midst, reminds him of the pleasures of the table, ere he arrives at a well-appointed refreshment bar.

Instead of continuing his circuit along the eastern arcade, he ought to return to Lady Brassey's case, descend the short staircase, and proceed down the long vista of British sea fisheries exhibits, which extends in a westerly direction for about 900 feet. It would be out of place here to enter into a detailed description of the numerous appliances—boats, tackle, cloths, &c.—which decorate the divisions of this gallery in the most attractive manner, and which cannot fail to elicit a fair share of his attention. Suffice it to say that he may pause with the crowd to glance at Grace Darling's portrait, to wonder what ladies' stockings, etc., produced on the hand-knitting machine, have to do with fisheries, or, may be, to betake himself to a dining-saloon which would satisfy the spirit of a gourmet, or even a Vitellius.

The long gallery is a thing of the past, and he finds himself compelled to turn somewhere. To the right is an open passage flanked on one side by a refreshment stall, on the other side by sheds with machinery in motion and for the production of the electric light; let him turn thither, and ascend the staircase placarded "Aquarium." Every step in this direction will be found replete with interest to him.

On the threshold of the aquarium he will linger, attracted by a huge bill on which some of Dr. Hassall's admirable drawings are reproduced, illustrative of the organic and other impurities found in drinking water. It is an advertisement for Maignen's patent "Filtre Rapide;" and so efficiently does this apparatus purify and aërate water, that even minute particles held in suspension, as in a solution of potassium permanganate (Condy's Fluid) are effectually removed from it. The filter is also adapted to purify sea-water, and render it suitable for aquaria in which living fish may be reared, and fed on only such foods as are suitable. In future papers we shall give a few illustrations of the chief forms of substances, living and dead, which are detrimental to drinking and potable water.

The aquarium, with its curious inmates and the model tanks, showing the culture of fish and molluscs, are of vast interest to the student of natural history, and will be carefully described in subsequent issues. The rooms surrounding and beyond the aquarium are occupied by exhibitors of pisciculture, and of ornamental aquaria, and fish. Amongst the latter we may here notice some very fine examples of the horse-fish (*Hippocampus*), procured from the Mediterranean Sea, and exhibited by Mr. King, of Great Portland-street.

The gallery of live stock comes to a close with Mr. Thomas Bolton's living organisms for the microscope. On Mr. Bolton's tables, a number of microscopes are carefully adjusted over forms of plant and animal life. We desire to draw special attention to these exhibits, for they bear directly upon some of the great questions concerned with the life-history of fish of all descriptions, the vicissitudes of their existence, and the influence of many of the minuter organisms upon their environment—questions which we can only hope to elucidate with the aid of the microscope brought to bear upon the details of minute structure. We shall have occasion to repair to Mr. Bolton's section frequently, and furnish our readers with illustrations taken

from his specimens. The student of natural history will linger with delight over Mr. Bolton's microscopes, and see there not only the embryonic stages of many fishes and molluscs, but the minuter particles, living and dead, which sustain the growing young and adult individuals. The proteus animalcule (*Amœba*) may be watched creeping over the sides of his zoophyte troughs and live boxes, whilst in another receptacle a few unfortunate young trout may be seen in a state of uneasy excitement, occasioned by relatively huge parasites, or fish-lice (*Argulus foliaceus*), which infest them; one of these placed under the microscope reveals its formidable suckers and hooklets, whereby it attaches itself to its victim; it belongs to the group of animals which includes the crab and lobster (*Crustacea*). Nor is Mr. Bolton's department devoid of local interest; with the ardent zeal of a lover of natural history, he has been scraping and gathering from the pond beneath the memorial to the Prince Consort in the exhibition grounds, which are now stocked with fresh-water fish, and has brought to light myriads of organisms calculated to agree and disagree with the appetites of the imprisoned captives.

Mr. Bolton's exhibit closes the living portion of the exhibition, and dead life now becomes the dominant feature of its galleries. A remarkably large walrus flanks one side of the short staircase which leads to the west quadrant; it is a pity that this magnificent specimen has not been suitably cased in glass; nevertheless it is worthy of attention, and an interesting printed circular, relating to the habits of the walrus, and its geographical distribution, may be obtained from the exhibitor.

The west quadrant, the northern gallery, and the east quadrant are devoted to stuffed specimens of fish, fish-eating birds, &c. Amongst the more noteworthy of these are the collection of plaster casts, by the late Mr. Buckland, the stuffed specimens of exceptionally-large and well-marked forms, which testify to the skill of the angler, and remind the student that, apart from economy and study, fish and fishing have afforded him the pleasurable and healthy beguilement of many happy hours with rod and line, over moorland and heath to wild lakes and rivers, or of the cool, bracing early morning in a fisher's smack far out at sea. The Fisheries Exhibition, then, admirably fulfils the two factors which we started with; it displays the results of economy combined with those of recreation.

The natural-history galleries are so complete that a hurried sketch here would tend but to confuse rather than enlighten the reader; we hope to visit them again, and to show him phases in the development of the salmon, collections of parasites which prey upon all kinds of fish, beautiful specimens of algæ, and exquisite accurate drawings of annelids; to comment upon them, and to learn the lessons they are intended to teach.

(To be continued.)

THE BIRTH AND GROWTH OF MYTH.

VIII.

By Edward Clodd.

THE beliefs of the ancient Finns in the world as a divided egg, of which the white is the ocean, the yolk the earth, and the arched shell the sky, and of the Polynesians that the universe is the hollow of a vast cocoa-nut shell, at the tapering bottom of which is the root of all things, are to us so grotesque that it is not easy to regard them as explanations seriously invented by the human mind. Yet these, together with the notions of the two halves of the shell of Brahma's egg, and of the two calabashes which form the heaven and the earth in African myth, find their correspondences in the wide-spread conception of the overarching firmament as a hard and solid thing,* with holes (or windows †) to let the rain through, with gates through which angels descend, ‡ or through which prophets peer into celestial mysteries; § a firmament outside which other people live, as instanced by the Polynesian term for strangers, "papalangi," or "heaven-bursters."

They are the less refined forms of myths which have held their ground from pre-scientific times till now, and the rude analogies of which are justified by the appearances of things as presented by the senses. Man's intellectual history is the history of his escape from the illusions of the senses, it is the slow and often reluctant discovery that nature is quite other than that which it seems to be. And this variance between appearances and realities remained hidden until the intellect challenged the report about phenomena which the sense-perceptions brought. For in the ages when feeling was dominant, and the judgment scarce awakened, the simple explanations in venerable legends sung by bard or told by aged crone—legends to which age had given sanctity which finally placed them among the world's sacred literatures—were received without doubt or question. But, as belief in causality spread, men were not content to rest in the naïve explanations of an uncritical age. What man had guessed about nature gave place to what nature had to say about herself, and with the classifying of experience science had its birth.

Meanwhile, until this quite recent stage in man's progress was reached, the senses told their blundering tale of an earth flat and fixed, with sun, moon, and stars as its ministering servants, while gods or beasts upbore it, and mighty pillars supported the massive firmament. In Hindoo myth the tortoise which upholds the earth rests upon an elephant, whose legs *reach all the way down!* In Bogotà the culture-god Bochica punishes a lesser and offending deity by compelling him to sustain the part of Atlas, and it is in shifting his burden from shoulder to shoulder that earthquakes are caused. The natives of Celebes say that they are due to the world-supporting Hog as he rubs himself against a tree; the Thascaltecs that they occur when the deities who hold up the world relieve one another; the Japanese think that they are caused by huge whales creeping underground, an idea probably confirmed by the discovery of monster fossil bones.

As the myths about earth-bearers prevail in the regions of earthquakes, so do those about subterranean beings in the neighbourhood of volcanoes. The superstitions which mountainous countries especially foster are intensified when the mountains themselves cast forth their awful and devastating progeny, "red ruin" and the other children born of them. Man in his dread, "caring in no wise for the external world, except as it influenced his own destiny; honouring the lightning because it could strike him, the sea because it could drown him,"‖ could do naught else than people them with maleficent beings, and conceive of their sulphur-exhaling mouths as the jaws of a bottomless pit.

Indeed, if in freeing ourselves from the tyranny of the "solar" theory we shackled ourselves with some other, we

* "And said the gods, let there be a hammered plate in the midst of the waters, and let it be dividing between waters and waters." Gen. i, 6. The verb from which the substantive is derived signifies, among other meanings, "to beat out into thin plates."

† Gen. viii. 2. ‡ Gen. xxviii. 17. § Ezekiel i. 1.

‖ "Modern Painters," Vol. III., 154.

should certainly prefer that which is known as the "meteorological," and which, in the person of Kuhn and other supporters, finds a more rational and persistent source of myth in phenomena which are fitful and startling, such as hurricane and tempest, earthquake and volcanic outburst. Sunrises and sunsets happen with a regularity which failed to excite any strong emotion or stimulate curiosity, and the remotest ancestor of the primitive Aryan soon shook off the habit—if, indeed, he ever acquired it—of going to bed in fear and trembling lest the sun should not come back again. Nature, in her softer aspects and her gracious bounties—in the spring-time with its promise, the summer with its glory, the autumn with its gifts—has moved the heart of man to song and festival and procession; as, by contrast, the frost that nipped the early buds and the fierce heat that withered the approaching harvest gave occasion for plaintive ditty and sombre ceremony. It is in the fierce play and passionate outburst of the elements, in the storm, the lightning, and the thunder, that the feelings are aroused and that the terror-stricken fancy sees the strife of wrathful deities or depicts their dire work amongst men. Hence, all the world over, the Storm-God and the Wind-God have played a mighty part.

To the savage, the wind, blowing as it listeth, its whence and whither unknown, itself invisible, yet the sweep and force of its power manifest and felt, must have ranked amongst the most striking phenomena. And, as will be seen hereafter, the correspondences between wind and breath and the connection between breath and life, added their quota of mystery in man's effort to account for the impalpable element. In the legends of the Quiches, the mysterious creative power is Hurakan (whence *hurricane*); among the Choctaws the original word for Deity is Hushtoli, the storm wind, and in Peru to kiss the air was the commonest and simplest sign of adoration to the collective divinities. The Guayacuans of South America, when a storm arose and there was much thunder or wind, all went out in troops, as it were to battle, shaking their clubs in the air, shooting flights of arrows in that direction whence the storm came.* But we are some steps nearer to the primitive myth when we find the wind conceived of as a mighty bird—which, indeed, is in both old and new world mythology a common symbol of thunder and lightning also. On this matter Dr. Brinton's remarks bear quoting:—

> Like the wind, the bird sweeps through the aërial spaces, sings in the forests, and rustles on its course; like the cloud, it floats in mid-air, and casts its shadow on the earth; like the lightning, it darts from heaven to earth to strike its unsuspecting prey. These tropes were truths to savage nations, and led on by that law of language which forced them to conceive everything as animate or inanimate, itself the product of a deeper law of thought which urges us to ascribe life to whatever has motion, they found no animal so appropriate for their purpose here as the bird. Therefore the Algonkins say that birds always make the winds, that they create the waterspouts, and that the clouds are the spreading and agitation of their wings; the Navajos, that at each cardinal point stands a white swan, who is the spirit of the blasts; so, also, the Dakotas frequently explain the thunder as the sound of the cloud-bird flapping his wings; the lightning as the fire that flashes from his tracks, like the sparks which the buffalo scatters when he scours over a stony plain.

Turning to the literatures of higher races, we find in the prose Edda, when Gangler asks whence comes the wind, that Har answers him: "Thou must know that at the northernmost point in the heavens sits a giant,

> "In the guise of an eagle;
> And the winds, it is said,
> Rush down on the earth
> From his outspreading pinions."

* Dorman's "Primitive Superstitions," p. 350.

In the Veda, the Maruts, or Storm-gods, to whom many of the hymns are addressed, "make the rocks to tremble and tear asunder the kings of the forest," like Hermes in his violence and like Boreas in his rage. Whether or no they become in Scandinavian legend the grim and fearful Ogres swiftly sailing in their cloud-ships, we may see in them the "crushers" and "grinders,"* as their name imports, the types of northern deities like Odin, long degraded into the Wild Huntsman and his phantom crew, whose uncouth yells the peasant hears in the midnight air.

Of this personification of the elements, the following Ojibway folk-tale, cited by Dorman, gives poetic illustration:—"There were spirits from all parts of the country. Some came with crashing steps and roaring voice, who directed the whirlwinds which were in the habit of raging about the neighbouring country. Then glided in gently a sweet little spirit, which blew the summer gale. Then came in the old sand-spirit, who blew the sand-squalls in the sand-buttes toward the west. He was a great speech-maker, and shook the lodge with his deep-throated voice, as he addressed the spirits of the cataracts and waterfalls, and those of the islands who wore beautiful green blankets."

In his valuable book on the Myths of the Red Race, Dr. Brinton has brought together a mass of evidence in support of a theory that the sanctity in which the number Four is held amongst that people is due to the adoration of the cardinal points, which are identified with the four winds, who, in hero-myths, are the four ancestors of the human race. Certainly the illustrations with which the argument is supported are both numerous and valuable; but any elaborate system of mythology based upon a definite number of winds has, like the solar theory, to make the facts square with it, and while it explains much, to leave much unexplained. Here this bare reference to it must suffice.

Estimates differ much as to the size of the Thunder-Bird. In one tradition, an Indian found its nest, and secured a feather which was above two hundred feet long, while in another tradition the bird is said to be no bigger than one's little finger! But among the Western Indians he is an immense eagle. "When this aërial monster flaps his wings, loud peals of thunder roll over the prairie; when he winks his eye it lightens; when he wags his tail the waters of the lake which he carries on his back overflow and produce rain." The old and universal belief that stones were hurled by the Thunder-God is not so far-fetched as we, in our pride of science, might think, for the flints which are mistaken for thunderbolts, and which become objects of adoration as well as charms, produce a flash when struck by the lightning. Mixcoatl, the Mexican Cloud-Serpent, as well as Jove, carries his bundle of arrows or thunderbolts, which in the hand of Thor are represented by his mighty club or hammer.

As in the conflict raging in the sky during gale or tempest, when the light and the darkness alternately prevail, the barbaric mind sees war waged between the heroes of the spirit-land who have carried their unsettled blood-feuds thither, so in many myths the lightning is no comrade of the thunder, but its foe, the battle of bird with serpent. The resemblances of the lightning flash to the sharp, sudden, zigzag movements of a creature so mysterious, to barbaric man, in its unlikeness to the beasts of the field, account for the myth, the interest of which lies for us in the correspondences which it suggests with the group

* From Sans. *mar*, "to grind." Ares and Mars come from the same root.

of storm-myths and sun-myths of the Aryan race, the battle between Indra and Vritra, Ormuzd and Ahriman, Thor and Midgard, Hercules and Cacus, Apollo and Python, and St. George and the Dragon. It is with the physical origin and, for us, deep theological significance of these, that the succeeding paper will deal.

PLEASANT HOURS WITH THE MICROSCOPE.

By Henry J. Slack, F.G.S., F.R.M.S.

THERE is now a general consent amongst the leading experimenters in medical science that consumption and a whole group of tubercular diseases are caused by the action of the minute organism noticed by Koch, and named *Bacillus tuberculosus*. Former articles upon micro-ferments afford some information concerning the class of bodies to which the *bacillus* belongs. *Bacteria* and *bacilli* are minute straight rods, of a beaded character, stationary, or with a vacillating motion, while analogous spiral objects (*spirilla*), often very much larger, corkscrew their way with considerable rapidity. Bacteria have long been suspected of connection with various diseases, and the action of some traced, but it is only recently that the *Bacillus tuberculosus* has been discovered. It can only be well seen when prepared by a skilful operator, and then the highest powers can only show it like very small cuttings of fine thread, which are resolvable into rows of a few beads when the illumination is carefully managed. A slide now under view was prepared from the sputa of a consumptive patient, staining it, with an aniline dye, a purple tint; removing that tint from the organic *débris* and leaving it in the bacilli, which hold it with greater stability. A power 300× shows no structure at all, but one of about 1,000 indicates beads more or less plainly as the illumination is suitable, and the object uninjured by the process of mounting. Three, or four, or five beads (occasionally a few more) either in an invisible tube, or simply in linear contact, make objects which, so magnified, seem from an eighth to a third of an inch long, and many millions of them would scarcely have enough weight to be represented in figures that could convey any meaning if stated in fractions of a grain. Dr. Burney Yeo reckons these bacilli as from a quarter to half a blood corpuscle in length, and the human corpuscle to which he refers is found to be from 1-3,200″ to 1-3,500″ in diameter. They vary in size, but are always minute. He tells us that in some rods oval spherules have been noticed. The temperature of the human body is advantageous for their growth, and probably a single bead of inconceivably small weight may suffice to start a rapidly-growing colony.

Doctors find the mischief done by these organisms to begin with an inflammatory accumulation of cells producing little nodules in the organ attacked. As their action increases, lumps of cheesy matter are formed at the expense of the tissues, and in violent cases the process of destruction is fearfully rapid. It has been ascertained that tubercular disease can be communicated by inoculating animals with this bacillus. Breathing air emitted from the lungs of affected persons seems, under some circumstances, capable of producing the disease; but, probably, in all such cases, there is something in the system of the party attacked which specially favours the growth of the deleterious organism. Dr. Yeo mentions many cases in which husbands and wives, living and sleeping together, have not transmitted the infection of consumption; but in other instances this has probably occurred; and one man, mentioned by Dr. Webber, is believed to have infected four wives in succession, and then he himself died of consumption, after giving up a seafaring life. The nurses and servants of the Brompton Hospital have been very free from tubercular disease; and when, at one time, the patients suffered from defective ventilation, there was no increase of consumptive attacks, but a large crop of erysipelas.

Pyæmia is now ascribed to micrococci, or little spherules, septicæmia to bacilli, relapsing fever to spirilla, and erysipelas is also traced to a micrococcus. It appears that this disease sometimes affords relief from other complaints, and Fehleisen grew its organism artificially, and then inoculated seven selected patients, producing erysipelas. The *British Medical Journal* says, in reference to these experiments on human beings, that they "were perfectly justifiable" (?), and states that one case of lupus (a horrible skin disease) was completely cured.

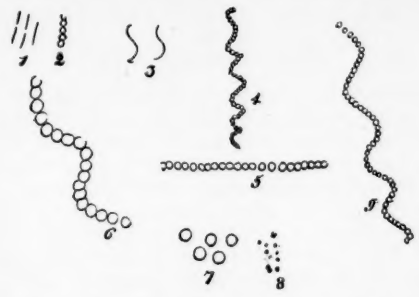
The question arises, are the bacilli which produce different diseases different species of organisms, rigidly reproducable in the line of hereditary descent, with uniformity of properties? Sometimes, of two objects that look alike, one can be distinguished by its more readily taking and holding a particular dye; sometimes the identity, or difference, of species is assumed on account of the properties manifested. Pasteur's experiments with the organisms producing splenic and some other diseases show that, by growing them under different conditions, their infectiousness can be attenuated to any extent; and if we look to the larger fungi, we find them wholesome or poisonous, according to the circumstances of their development, climate, soil, shelter of trees, or in open spaces.

A small spherule, or a little rod, may or may not be capable of development into other forms, and this can only be found out by elaborate investigations. With many of the lower organisms it by no means follows that because many generations may be grown like their parents, another type, so far as appearance goes, may not occur under fresh conditions, either of external circumstance or internal state. Mr. Dallinger's researches into the life-history of certain monads abundantly prove that such changes do occur. Spirillum at one period becomes less twisted, and finally straight, according to Messrs. Geddes and Ewart, and a great variety of bodies are developed from round or oval spores, not distinguishable from each other except by watching their development. Many spores can pass through the digestive organs of animals without injury.

Dr. Matthews found spirillum developing from its spores when he broke up a little excrement of a goat in distilled water; and sewage matter is a too well-known nidus of disease-causing organisms. One of the most remarkable statements in reference to the minuteness of the quantity of matter capable of generating disease was made to the Royal Microscopical Society in May, 1882, by Mr. G. F. Dowdeswell, who said, in the case of the bacteria called after its discoverer, Davaine, that the blood of rabbits containing it "is usually infective up to the millionth and the hundred millionth part of a drop; sometimes even in smaller quantities, obtained by successive dilutions."

The subjoined figures will help the beginner in recognising some of the organisms mentioned. Figs. 1 and 2 represent *bacillus tuberculosus* magnified about 500 times and about 1,000, the latter being in beads. Fig. 3 is a common form in the scum of infusions; 4, a spirillum considerably magnified. These objects vary in size. 6 and 9 are other forms; 5, a long bacterium form; 7 and 8, spores and micrococci. It is only by long practice that any one can

tell, or guess, what some of these minute beads may really be. Those which are harmless, and those which may give rise to diseases are not marked out by obvious or striking characters. Many of these organisms become visible if allowed to dry on a slide, and many are very ready to take



aniline dyes. Minute bacteria, unnoticeable in water, are easily seen as it evaporates, and some are sure to be found where decomposition is going on. Giving such objects specific names, unless something is known of their origin or life history, is merely playing with words.

THE AMATEUR ELECTRICIAN.

BATTERIES.—I.

NOTWITHSTANDING the fact that galvanic batteries have been more or less well known during the past half-century, their functions, and the conditions they are called upon to fulfil are even now, in this "age of electricity," but very imperfectly appreciated by many of those whose business or pleasure it is to deal with them. That we are not unduly emphasising this somewhat widespread ignorance is evidenced in many ways, more especially amongst amateurs (a term in which we venture in this particular instance to embrace all who are not engaged as professional electricians). It is no very unusual thing to be asked how many Daniell cells would suffice to maintain a dozen or more incandescent electric lamps, although their inefficiency for the purpose should be apparent to the merest tyro in applied electricity. Then, again, the relative advantages and disadvantages pertaining to the various forms of battery for any particular purpose may to some extent be known, while the causes for such peculiarities are, so far as the experimenter or operator is concerned, enveloped in the deepest oblivion.

Very frequently the question of applicability resolves itself into one of simple electrical measurement. At other times—and more especially is this the case with modern attempts to "improve" the Daniell battery—the discontinuity of the chemical reactions, and the imperfect absorption of nascent hydrogen, result in intermittent currents, whose "pressure" (or electro-motive force) and strength are constantly varying.

The object in view in these papers is to describe, as succinctly as possible, the principles involved in the construction of the various typical forms of battery, giving, at the same time, their numerical efficiency, approximate cost, results of experiments on their durability and utility, and such other matters of interest as may present themselves, not omitting to furnish details for their simple and inexpensive construction.

It is desirable, in the first place, that any one who is about to adopt a battery for any specific purpose should have a clear conception of the rudimentary principles involved in the doctrine of the "conservation of energy." There is not, in the whole range of science, a grander or more universally true doctrine than this, nor is there any similar collection of principles, a knowledge and appreciation of which will prove so useful in protecting one against the allurements of an innumerable host of impostures. Amongst the more recent attempts at "perpetual motion," none are more daring, nor more frequently put forward, than those which are based on electricity, and scientific lecturers are often guilty of misleading people by statements and experiments, which they, however, probably intended to have a widely different effect. For instance, it is often put forth as among the wonderful applicability of electricity that a passing current may be made to simultaneously deflect a galvanometer, raise a weight, decompose water, render a piece of wire or a carbon filament incandescent, and perform a long list of other experiments too numerous to detail. But how many lecturers are there who supplement the experiment by saying that the amount of force expended in all these operations cannot possibly exceed the capacity for performing any one of them; and yet such a law is easily demonstrated. If a current is allowed to pass through the coil of a galvanometer without having any other work to perform, we shall get a deflection of, let us say, 40°. If now we insert an electro magnet in the circuit, the deflection of the needle (or the work performed in forcing it out of the position assigned to it by gravity) will be sensibly reduced. Here, then, is simply and incontrovertibly demonstrated the fact that a current of electricity can no more be called upon to perform a second kind of work without the first being proportionately reduced, than can a boilerful of steam. Similarly, if we insert an electro magnet in circuit with an incandescent lamp, the luminosity (or the heat developed in the filament) will be proportionately reduced.

The most important battery at present in use is that known as the Daniell, of which there are, as might be expected, a large number of modifications. The principle, however, is never denied to Daniell, who is justly regarded as the father of practical batteries, as the man who contributed almost, if not quite as much as Morse or Wheatstone to make telegraphy a part of every-day life. The size and shape of the to-be-adopted battery will depend considerably upon the requirements of the case. Where the external resistance is low, large plates are required; and where potteries are scarce, or electrical instrument-makers exorbitant in their charges, a cylindrical is preferable to a square form. A cell of one quart capacity is perhaps the most generally convenient size. It may be put together very easily. In a glazed earthenware or other non-porous jar place a cylinder of zinc. The zinc should be about a quarter of an inch thick, and should stand as high as the jar is deep. Where space is not an important factor it will be found cheaper to use a large earthenware pot and a flat piece of zinc, the bending of which is generally troublesome, at least to the amateur. Inside the zinc cylinder place a porous pot, standing half an inch or an inch above the zinc, and containing a sheet of very thin copper, bent into an approximately cylindrical shape. Nearly fill the porous pot with crystals of pure bluestone (sulphate of copper, $CuSO_4$); then fill up both the glazed jar and the porous pot to within half an inch or an inch of the top of the outer jar. If required for immediate use, add a small quantity of sulphuric acid to the water in the zinc division, making the proportion about 12 of water to 1 of acid. Terminals, or binding screws, should be attached to the

zinc and copper plates, it being always carefully borne in mind that clean and thorough metallic connections are absolutely essential, more especially where we are dealing with currents of low electro-motive force, such as are generated by a few battery cells. The cost of a Dainell cell is, as we said, small; the outer jar and porous pot should be procurable for a few pence. A pound of thin copper (at, say, 1s. 8d.), would be sufficient to make several plates 4 in. by 5 in. Zinc ought not to cost more that 5d. per pound, and a plate of ¼-inch metal, 5 in. by 3 in., weighs a trifle over one pound. The terminals cost about 6d. each, but vary considerably according to shape and size. Pure sulphate of copper costs 6d. per pound, about ¼ lb. being required for each cell.

The principles involved in the Daniell cell have been very extensively written and talked about; but a brief summary will not detract from any value pertaining to this particular description. In the zinc division, the action brings about an absorption of zinc, which is converted by means of sulphuric acid into sulphate of zinc. Hydrogen is at the same time released, which, entering the porous pot, displaces the copper from its sulphate, forms sulphuric acid, and precipitates the purest possible copper on the negative or copper plate. Reduced to an equation, we get

$$Zn + SO_4H_2 + SO_4Cu = SO_4Zn + SO_4H_2 + Cu.$$

Thus it will be seen that the liquid in the zinc division becomes gradually a more and more concentrated solution of sulphate of zinc, while the sulphate of copper solution is reduced or weakened *at the same rate*, and were there no reserve stock of crystals in the cell, the liquid would soon become colourless, and hydrogen would be deposited on the copper plate. It must, however, be remembered that the one great function of the bluestone solution is to prevent any deposition of hydrogen, because an accumulation of that gas upon the copper plate results in the rapid cessation of the current due to the insulation of the plate. A further point to be noticed in this "polarisation" process is that counter currents are started from the hydrogen film to the zinc plate. It will be seen from the above equation that for every atom of zinc dissolved, an atom of copper is deposited, and this explains why it is that a thick zinc plate is advisable, while there is practically no limit to the thinness of the copper plate. In fact, batteries have been constructed without any copper plate, the action being relied upon to deposit a coating of copper upon a sheet of lead or other conducting substance. The atomic or relative weights of zinc and copper are 65 and 63·5 respectively, so that for every 65 grains of zinc dissolved, the weight of the copper deposited will be 63·5 grains. The molecular or relative weight of copper sulphate is 159·5, so that for 63·5 grains of copper deposited, 159·5 grains of copper sulphate will be converted into sulphuric acid. The sulphate of the zinc solution should not be allowed to get too strong, otherwise a formation of insoluble zinc salts will take place. The solution, which is advantageous up to a certain point, requires, therefore, to be partially removed occasionally, and the cell filled up with water.

The Daniell cell has an electro-motive force of 1·079 volts (see Electrical Measurement I.), the internal resistance of the cell varying directly as the surface of the plates, and inversely as the distance between them. The small cells used by the Post Office offer 10 Ohms per cell, but the resistance of such a cell as the one above described would be 3 to 4 Ohms.

As the source of a constant current, the Daniell cell is, for currents of such dimensions as it is capable of maintaining, as near perfection as anything human can make it. For this reason it is second to none where a constant and steady current is required, and is extensively adopted in telegraphy and electro-metallurgy.

In consequence of the diffusion of the sulphate of copper into the zinc division, a precipitation of copper at the expense of the zinc is always going on, and the bluestone proportionately wasted. This action is represented by the equation

$$SO_4Cu + Zn = SO_4Zn + Cu.$$

The copper is deposited on the surface of the zinc, at the bottom of the cell, and, generally speaking, wherever the zinc touches. To prevent this as much as possible, the bottom of the porous pot should be immersed for a few minutes in melted paraffin wax. The upper portion of the pot which stands out of the solution should be similarly treated, to hinder the creeping of the solutions. Both the zinc and the copper sulphates creep considerably, and, the water evaporating, the sulphates crystallise. Being more or less damp, they may easily short-circuit the cells. When any crystals are observed on the upper portions of the elements, the cell should be wiped with a damp cloth. It is found that the consumption goes on in an idle cell almost as rapidly as in an active one, and accordingly the Daniell cell is never to be recommended where only occasional currents are required, as is the case with electric bells, &c. In fact, if adopted for such purposes, the Daniell cell would soon eat its head off. Nor, again, is this battery advantageous where strong currents, or currents of high electro-motive, are required for a short period. Other forms of battery are available for such purposes, and will in their turn come in for description.

LAWS OF BRIGHTNESS.

II.

BY RICHARD A. PROCTOR.

WE are next to consider the degree of brightness with which an opaque body is illuminated, according as its distance and position vary with respect to the source of light.

It will be sufficient to consider here only the case where the illuminating body is so far off that, as seen from any point of the opaque surface, it would appear very small.

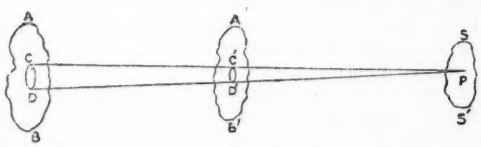


Fig. 3.

Suppose A B (Fig. 3) to be a plane opaque surface squarely illuminated by a luminous surface, S S'. Let a small luminous area at P emit towards the small circular area C D of A B the pencil of light, P C D. Then, if the area A B be shifted to the position A' B', its plane remaining still square to the light rays from S S', the pencil, P C D, falls upon the small circular area, C' D', and obviously illuminates this area, C' D', more brightly than C D in the proportion that the area C D exceeds the area C' D'. But the area C D is to the area C' D' as the square of C D to the square of C' D', that is, as the square of P C to the square of P C'. Hence the point P illuminates the area A' B', more brightly than the area A B, as the square

of the distance A B exceeds the square of the distance of A′ B′. The same is true for all parts of the surface S S′. Hence the illumination of A B is to the illumination of A′ B′ inversely as the square of the distance of A B is to the square of the distance A B. The same reasoning would obviously apply if A B were inclined at any angle to C P. and the plane A′ B′ parallel to the plane A B. Hence we have the law that *the illumination of similarly placed opaque surfaces varies inversely as the square of the distance of the source of light.*

Next, as to the effect of the inclination of the opaque surface to the light rays falling upon it.

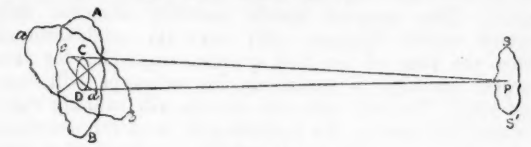


Fig. 4.

If A B C D, Fig. 4, represent the same areas as A B, C D in Fig. 3, and A B be tilted to the position *a b*; then if the oval *c d* be the intersection of the plane *a b* with the conical pencil C P D, the area of the oval *c d* is to the area of the circle C D (by a well-known property of projection) as 1 to the cosine of the angle between the planes A B, *a b* (the point P being regarded as so far off that *c* C and D *d* are appreciably parallel). But the angle

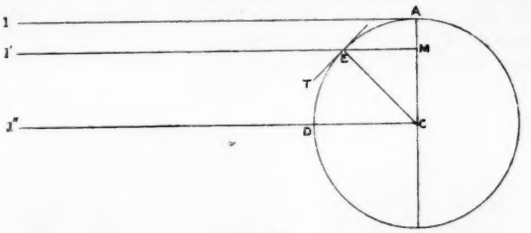


Fig. 5.

between the planes A B and *a b* is the complement of the angle between P *c* and the plane of *a b*. Hence the area *c d* is to the area C D as 1 to the sine of the angle between P *c* and the plane *a b*. Since then only the same amount of light falls on the larger area *c d* as on the smaller area C D, it follows that the illumination of *c d* is to the illumination of C D in the ratio of the sine of the angle between P *c* and the plane *a b*. This being true for all points of S S′, we deduce the law that *the illumination of an inclined opaque surface varies as the sine of the angle between the light rays and the surface*, or *as the cosine of the angle between the light rays and a line perpendicular to the surface*, this last-named angle being called *the angle of incidence.*

These laws are sufficient for the cases of the opaque celestial bodies. For terrestrial objects under illumination from large sources of light—as, for instance, a body illuminated by the sky, either the complete hemisphere of sky (the sun being supposed to be out of view) or some given portion thereof—other considerations have to be taken into account. For lines from different parts of the sky do not meet the surface at the same angle. For our present purpose these cases need not be considered; nor, indeed, do they usually admit of the same kind of treatment as problems in celestial illumination; simply because bodies which are exposed to light from many different directions are commonly exposed to a good deal of reflected and scattered light from objects of very different degrees of reflective power, and few cases arise where the exact consideration of the resulting degree of illumination is worth the trouble it would involve.

Now, let us consider some results of the laws of illumination of opaque bodies under light from a distant source.

In the first place, it is obvious that a planet being illuminated proportionately to the inverse square of the distance will appear intrinsically brighter or fainter in a corresponding degree, neglecting for the moment the different reflective powers of different surfaces) from whatever station it may be viewed. Its brightness as a whole will, of course, depend on the position of the observer, but its intrinsic brightness will be independent of this consideration. Thus, supposing that with the same telescope an observer views in succession all the planets from Mercury to Neptune, and that reducing the field of view he sees only a small part of the planet's disc, *on which the sun's rays were falling squarely*, then supposing the planets to have surfaces of similar reflective power, these successive areas would differ in lustre as—

$$\frac{1}{(\text{Mercury's dist})^2} : \frac{1}{(\text{Venus's dist})^2} : \frac{1}{(\text{Mars' dist})^2} : \&c.,$$

wherever the planet might be placed. Of course the italicised *proviso* could not be attended to in the case of Mercury and Venus if these planets were in the nearer half of their orbit; but with these exceptions it is always possible to bring a part of a planet which is under square solar illumination into a small field of view. However, in the preceding remarks I have not had in view the description of an experiment to be tried, but rather the illustration of a certain relation.

It follows that so far as the effects of actual solar illumination are concerned—that is, setting aside the reflective qualities of the different planets—we should have the intrinsic brilliancy of the planet's surfaces related in the following manner (where the earth's illumination, when at her mean distance, is taken as unity):—

	In Perihelion.		Aphelion.
Mercury	10·58	...	4·59
Venus	1·94	...	1·91
Earth	1·034	...	0·967
Moon	1·034	...	0·967
Mars	0·524	...	0·360
Jupiter	0·0408	...	0·0336
Saturn	0·0123	...	0·0099
Uranus	0·0027	...	0·0025
Neptune	0·0011	...	0·0011

It will be observed that the moon is here included as the earth's fellow planet rather than as a satellite. It ought, indeed, to be held in view that the moon really circuits the sun as a planet would do, undergoing rather considerable perturbations, but traversing what may be properly described as an elliptic orbit, having the same aphelion and perihelion as the earth's.

We shall presently see that the table just given, which is, of course, the ordinary table of the light received by the several planets, has to be considerably modified to indicate the actual apparent brilliancy (intrinsic) of the planetary surfaces under direct solar illumination. The table is useful, however, as indicating what may be called the normal ratios of planetary intrinsic brightness.

(To be continued.)

HUNGARIAN STATE RAILWAYS.—The net profit realised in 1881 upon the Hungarian State lines was £681,418. This was equivalent to a return upon the capital engaged in the lines at the rate of 2·40 per cent. per annum

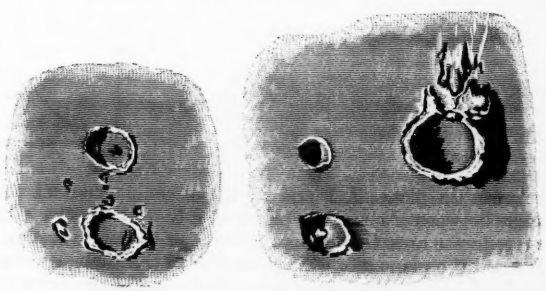
THE MOON IN A THREE-INCH TELESCOPE.

By a Fellow of the Royal Astronomical Society.

ADVANCING sunlight is now bringing into view a highly complicated mass of walled plains and craters in the south-western quadrant of the moon; and with some of the more notable among them we will begin our work to-night. Maurolycus (358 in our map) is a splendid object about the time of the moon's first quarter. The great complexity of the wall will attract the attention of the observer. A few crater pits may be detected with the instrument we are employing on the walls, as well as on the floor of Maurolycus, and there are numerous hills on the latter also visible under favourable illumination. Another splendid object in this neighbourhood is Stöfler (354), but the inside of this is very much more level and undisturbed than that of its neighbour. The system of bright streaks radiating from Tycho (previously referred to on p. 222), passes over this region, with the curious result that the bold and most conspicuous formations of which we are speaking to all intents and purposes disappear at full moon altogether! In Walter (200), Regiomontanus (201), and Purbach (202), we have an instance of three crater plains in connection with each other, and lying, approximately, north and south of each other, one example of which we have already seen in Theophilus, Cyrillus, and Catherine, and another of which we are immediately to examine in Arzachel, Alphonsus, and Ptolemy. North-east of Purbach lies Thebit (203), a crater well worth examining, as attentive inspection will show that another crater has burst the original wall, and has itself in turn been intruded on by a more minute one still. Here, again, we are able to trace the chronological sequence of the successive eruptions. A strange formation, known as "Straight wall," but looking (when the moon is eight or nine days old) like a stag's horn on the top of an alpenstock, will be noted not far to the east of Thebit. And now we arrive at that truly superb triple system, Arzachel (204), Alphonsus (207), and Ptolemy (208).

Arzachel, Alphonsus and Ptolemy.

Arzachel is about 65½ miles in diameter, with terraced walls, diversified by clefts and craters. Alphonsus is 83 miles across, and has very complicated walls. The northern one opens by clefts and valleys into Ptolemy—an enormous walled plain of 115 miles in diameter. The conspicuous crater in its floor will at once strike the eye. In Alphonsus, the chief object in the interior is a mountain; while in Arzachel both a mountain and a crater will be noted by the observer. In our sketch above, Alpetragius (205) will be seen to have its interior wholly immersed in shadow. This beautiful crater is about 27 miles across, and is so comparatively deep as to be only free from shadow for less than a week during the entire lunation. Herschel (212) is a fine ring plain, 24 miles in diameter, with a central mountain. Rhæticus (104) is noticeable as lying actually on the lunar equator. Godin (103) and Agrippa (102), two ring plains of 23 and 27 miles in diameter respectively, are fine objects when seen near the terminator. The observer should carefully examine that curious object Hyginus (93) and its neighbourhood about the time of the first quarter, employing for this purpose as high a power as his telescope will bear (say 160). He will note the curious rill running right through the crater, the snail-shaped or spiral mountain just to the north of it, a brilliant ridge to the west of this again, and so on. Hereabouts it is that the alleged discovery of the depression known as "Hyginus N." was made. The incipient observer with a 3-inch telescope must not, however, blame either himself or his instrument should he fail to distinguish this mysterious object. Manilius (95) is a fine object under proper illumination. Its diameter is 25½ miles. The Sea of Serenity, at which we now arrive (H) contains numerous objects to reward the observer. Among them is the curious one, Linné (74), which, save when almost *on* the terminator, presents the appearance of a minute whitish cloud, or little smudge of light. It may be found on a line drawn from Pliny (61) through Bessel (73). The two splendid



Eudoxus and Aristotle. Autolycus, Aristillus, and Archimedes.

craters, Eudoxus (77) and Aristotle (78) here drawn present a grand spectacle when near the boundary of light and darkness, either with a waxing or a waning moon. Our own sketch above was made when the sun was rather too high above their horizon. Under suitable illumination Aristotle will be seen to be surrounded by radiating chains of hills. Cassini (81) is a curious object about the time of the moon's first quarter. Its diameter is about 36 miles, and it contains a ring plain, some nine miles across, within it. The edge of the ring of Cassini must be considerably serrated or cut into peaks and spires. With Archimedes (120), Aristillus (83), and Autolycus (84), we shall conclude our work to-night. The examination of the region in which they are situated may well afford us an entire evening's occupation on a future occasion.

Archimedes is a comparatively shallow ring plain of 50 miles in diameter. The inside, with our instrumental means, will appear quite smooth; but powerful telescopes show minute craterlets and spots in it. When, however, this great plain is fully illuminated, a three-inch telescope will show that the floor is striped or streaked with alter-

nate light and darker bands. Archimedes is a grand object when the sun is either rising or setting upon it. Aristillus, 34 miles across, has a central mountain, shown in our sketch. Under rather more oblique illumination, ridges, like lava streams, may be seen radiating from the outer ring. Autolycus, 23 miles in diameter, is tolerably deep, but calls for no more special description here.

ERRATUM.—On p. 294 the order of the sketches of Messier is curiously inverted. Of course, that taken when she was 3·95 days old should stand first; next should come the one showing its aspect at full moon; while the drawing made when the moon's age was 17·8 days should stand third and last.

AGE OF THE MISSOURI.

BY E. P. WEST.*

THE Missouri, one of the grandest rivers of the world, washes the northern limit of Kansas City. We witness its annual floods, garnered by the vast accumulations of winter's snows in the far-off elevations of the Rocky Mountains. We see, year by year, the devastations caused by its wild waste of waters. We observe it, in its gentler moods, freighted with the products of many nations, destined to swell the commerce and add to the convenience and comfort of the enlightened and happy people occupying the environments of its picturesque shores. Generation after generation, age after age, witnesses the same occurrences; and we are apt to associate this great river with the geological formations cut by its turbid waters for all past time. But, while it is one of the largest, and apparently one of the oldest of rivers, it is, in truth, one of the youngest of this continent. When the St. Lawrence, the Cumberland, the Ohio, and the Upper Mississippi had attained their full growth and supremacy over the countries now tributary to them, the Missouri River was but in its infancy. When their systems of drainage were complete, all the vast territory now tributary to the Missouri, which lies within the limits of four great geological formations—namely, the Triassic, Jurassic, Cretaceous, and Tertiary, embracing a part of Iowa, the most of the States of Kansas and Nebraska, all of Colorado, and the territories of Wyoming, Dakota, and Montana—were covered by an ocean. The Missouri River was then but little more than four hundred miles in length, and its drainage covered less than half of Missouri and Iowa, and but a small part of the eastern portions of Kansas and Nebraska, its headwaters being not remote from Omaha, Nebraska. Then great reptiles, from forty to ninety feet in length, sported in this vast expanse of ocean, which, with some interspersed islands, extended westward over the western plains and Rocky Mountain regions, covering the entire country now drained by the Missouri River westward and north-westward of Omaha. The eastern borders of Kansas and Nebraska formed a part of the ocean's eastern shore line, and it was nowhere at a greater distance than two hundred miles from the eastern boundary of these States, the greatest distance being along the Kansas border.

The Triassic and Jurassic formations were the first to emerge from this old western ocean. These formations are exposed along a narrow strip of country, extending through Middle Kansas, and prolonged, perhaps, into Eastern Nebraska, but greatly widening to the south-west through the Indian Territory and Northern Texas. They added but little to the drainage of the Missouri River, and are conspicuous for the paucity of organic remains in them.

* A Paper read before the Kansas City Institute.

Next, the Cretaceous formation emerged and became dry land. This added to the Missouri's drainage a broad belt of country extending across Kansas and Nebraska, and northward of Omaha, through Dakota Territory, increasing the river's length more than four hundred miles, and adding very materially to its western tributaries. This formation is noted for the great abundance and gigantic proportions of its fossil reptiles and numerous invertebrate forms, as well as for several varieties of fossil wood, leaves, and plants, closely approximating present living species. Lastly, the Tertiary formation rose from the water, completing the Rocky Mountain system, and the drainage of the Missouri River to its present sources. By the uprising of this formation the remainder of Kansas and Nebraska, the most of Colorado, and the territories of Wyoming, Dakota, and Montana were made tributary to the waters of the Missouri. But we must not associate these various elevations with great catastrophes, or suppose them sudden or violent, but, on the contrary, we have reason to believe them slow and gradual, requiring long ages in their accomplishment. We must not, either, consider the Missouri, though among the youngest of rivers, so very young, counting its age by years, or comparing it, even, with man's duration upon earth, for it has witnessed stupendous and long-continued changes since it attained its majority and was adopted, full-grown, into the family of American rivers. Though young in comparison with the other great rivers I have named, some idea of its really great age may be formed when it is considered that the great and wide-spread mutations which gave it birth and built up our western river systems, occurred between the close of the Carboniferous age and the end of Tertiary time. The upper carboniferous rocks are to be found about Kansas City, and northward along the western border of Missouri and eastern borders of Kansas and Nebraska, and the Tertiary formations about the elevations of the Rocky Mountains and over their eastern slopes.

Next in sequence followed the events alluded to as having occurred since the Missouri river was increased to the full measure of its present drainage, namely, the Glacial and Champlain epochs which occurred in Post-Tertiary time. First, the glacial period was ushered in:—

> "Once the fierce Kabibonokka,
> Issued from his lodge of snow-drifts,
> From his home among the icebergs,
> And his hair, with snow besprinkled,
> Streamed behind him like a river,
> Like a black and wintry river,
> As he howled and hurried southward,
> Over frozen lakes and moorlands."

The entire country now tributary to the Missouri River was elevated far above its present level, and vast glaciers, thousands of feet in thickness, crept down from the northward to about the parallel of Kansas City. But before the country became mantled in snow and creeping rivers of ice, the Missouri River had carved out a channel to an unknown depth, but, perhaps, five hundred feet or more below its present bed. The old channel is found to be choked up with drift-sand and boulders, borne in by glacial action, and by this means the river was partly, and perhaps entirely, diverted in some places. These facts are made apparent by the achievements of modern civil engineering in overcoming obstacles to continuous railway transit. Nine railway bridges now span the Missouri River from Omaha downward to its mouth. All of the bridges approach one or the other of the river bluffs—generally those on the south side. In sinking piers to support the superstructure, solid rock has been found only on one side—*i.e.*, the side touch-

ing the bluffs, although excavations for this purpose were made at all of the bridges, in the river's bed, from sixty to more than one hundred feet deep. Consequently, some of the piers—in each instance, those most remote from the bluffs—rest on piles driven into the loose, erratic material which fills the old channel up to the river's present bed. These facts would seem to indicate that the old gorge of the river extended from bluff to bluff, and sloped, with more or less regularity, downward from the bluff on either side, toward the centre of the valley. It required a great lapse of time for the river to cut out such a channel, and long ages must have transpired between the close of the Tertiary era and the full inauguration of the Glacial epoch, between which events this work of attrition was done.

To comprehend this clearly, we must imagine a rock-bound canyon of variable width, cut through the carboniferous strata between the bluffs on either side of the river, to a depth of 500 feet or more, below the present bed, at the bottom of which the river was dashed in wild confusion; then we must conceive of vast rivers of ice, creeping down from the north, laden with great streams of stones and sand, to be emptied into the canyon, in quantities sufficient to fill and completely dam it up in many places; but, at the same time, it must be borne in mind that at the interval the glaciers reached the Missouri river the volume of water was greatly diminished in it, in consequence of the congelation of the snow and rainfall over all the country north of the 40° of north latitude.

The Glacial period is distinguished by its wide-spread distribution of erratic rocks over all the country north of the 40° of north latitude. It has but few fossil remains, and those, mostly of life which preceded it.

The Champlain epoch next followed, and was, in every way, in strong contrast with the Glacial period.

Most of the country along the Missouri River, which, during the Glacial time, had been elevated above the present level, in the Champlain era was sunk below it. Instead of intense cold, the climate was warmer than we now enjoy. Instead of vast fields of moving ice, still lakes prevailed along the Missouri River, co-extensive with the Loess formation now bordering it. Instead of an arctic waste, life teemed in the water and upon the land. The lakes were filled with fish, and the land abounded with animals. Among the animals the elephant and the mastodon browsed among the hills and valleys. The horse, much larger than the living species, the ox, and the bison grazed on the plains. A gigantic beaver, and animals of the sloth tribe, much larger than the moderns, prevailed. Among the carnivores there were bears, lions, and a species of racoon; and last, though not least, we have a glimpse of man playing a part for supremacy in this remote era. The remains of several of these animals have been found imbedded in the Loess deposits about Kansas City. This era is distinguished for its great deposits of brick clay, or Loess, its terrace formations, its gigantic mammals which have become extinct, and for the great number of its mollusks, which are identical with living species. Next, the era of mind was ushered in, and is still slowly fulfilling its promise of a higher destiny.—*Kansas City Review.*

TELEGRAPHY IN CHINA.—The establishment of a telegraph line was recently authorised between Shanghai and Tientsin. This line is now to be extended to Pekin. Telegrams are to be forwarded in French or English. Two mandarins have been appointed to keep a rigid surveillance over all telegrams, so that they may not in any way compromise the security of the State.

GEOLOGY AMONG THE COLLIERS.

ON page 311, col. 1, of last week's KNOWLEDGE is a quotation from the late Mr. J. Beete Jukes, which expresses an error into which many other eminent geologists have fallen—viz., that of supposing working colliers to be far more ignorant than they really are.

My own experience among them indicates that no average "practical man" of that class would make the mistake there described.

These practical colliers, especially "sinkers" of middle age and upwards, usually have a remarkably sound and intimate knowledge of the stratigraphical and palæontological characters of the coal-measures, though ignorant of the names of the most familiar fossils; and I can hardly understand the possibility of such men sinking "in black shales and slates in the lower rocks, far below the coal measures," without knowing that the coal was "up in the sky," to quote an expression I heard used by an old Welsh collier to a speculative gentleman who proposed to sink a pit for cannel not far from Mr. Gladstone's country residence at Harwarden.

The only geological book-lore of this old man was that contained in Genesis; yet, in spite of the fact that we were surrounded on three sides by the pit-heads and engine shafts of working collieries, and that the farmer who was with us had several times turned up with the plough large lumps of camel in the field on which we stood, the collier firmly denied the possibility of finding any below us.

He did so for the same reason that would have led Mr. Jukes to the like conclusion—viz., that we were standing over the Millstone grit, which his illiterate forefathers had named the "Farewell Rock," before modern geology existed as an acknowledged science. They so named it because they all knew that it lies below the coal-measures, and whenever it is reached in sinking they must bid farewell to coal-seams.

This terminus and all the strata above it, as they occur in particular districts, are as well known to the sinkers of each district as the stations on the Metropolitan Railway are known to born and bred cockneys.

Still, it is quite true, as Mr. Jukes says, that pits are sometimes sunk "deep into the Silurian shales," but under whose instigation and direction? Not those of working colliers, but of company-floating sharemongers, or wild speculators maddened by money-greed. With either of such masters the poor sinker dare not speak; the utterance of truth would infuriate the latter and convict the former, in either case bringing about the dismissal and persecution of the intermeddling truth-speaker.

Some sad cases of such persecution came under my own notice during the few years that I was engaged in cannel distilling and pit-sinking in Flintshire. I was able to rescue and employ in very responsible work one man who had suffered much from speaking undemanded truth to his employers, and was well repaid by the advantages which his fidelity, and sound, though unlettered, geological knowledge afforded me.

I must not be tempted into further personal details, but conclude by stating generally that by listening patiently to these men with willingness to be instructed by them I learned a great deal, and formed a much higher opinion of the intelligence and the moral worth of working colliers than is commonly entertained by those who judge them superficially by their black faces and rude speech.

I will just mention one incident for the instruction of those who regard them as rough and brutal. A friend was visiting at my house, "The Celyn," near Caergwrle, and on

returning from a walk asked me what was the matter with the big fellow he had just met in the hay-field. The man was crying like a child and mopping his tears with a dirty handkerchief. I was able to explain that he had walked from his cottage at Leeswond (four miles away over the Hope Mountain) to bid his master good-bye, as he was about to emigrate. He was simply one of my rough, poorly-paid labouring pit-sinkers.

W. MATTIEU WILLIAMS.

RATIONAL DRESS.

THE following suggestive letter, signed "A Woman," appeared in the *Times* of Thursday, May 22:—"Men have their say on women's dress, and decide autocratically what is or is not 'rational dress;' will you permit a lady to represent that men's costume is by no means perfect, and admits of much improvement as regards health, convenience, and grace? It is rather difficult to speak out plainly enough to substantiate my assertion as to the first point; but doctors will testify that there has been a great increase of late among young men of liver and kidney disease, not to speak of other delicate parts. This is owing, I believe, to the fashion which has prevailed of small cut-away coats, leaving loins and stomach unwrapt, save by the tight and often thin trousers. Older men frequently suffer from chill taken from sitting on damp seats, or cold stone, from which a woman would be protected by her more voluminous garments. The absurdity of the open coat and waistcoat, turned back just where the throat and chest needs covering, is more generally recognised. The practice of wearing, in winter, waiscoats cut very high, and the constant arguments for wearing a beard 'to protect my throat,' show that it is felt, though not often acknowledged in speech. The large expanse of starched shirt front, held together, perhaps, with but one small stud, is ridiculous in every way. It is a sham, for most, if not all, wearers supplement its deficiency by a warm vest below, which cannot, however, quite exclude a searching wind, or keen night air, after leaving a warm room, from reaching the lungs. It is not beautiful in itself, it becomes easily soiled, needs frequent repair, costly washing, and seldom sets as it should. The stiff collar, rasping chin, cheeks, and throat, is most inconvenient in every way. A far more rational dress for man was the doublet fastening to the throat, and covering the thighs with soft band or turn-down collar. We come now to the crucial garment so recommended for women's imitation—trousers. If these be so adapted to allow the free use of the limbs, how is it that men wear knickerbockers for bicycling, rowing, running, and climbing? I once heard a gentleman, who had been to a fancy ball in hose and silk stockings, exclaim, 'How jolly it is to dance without trousers.' I suppose he found they fettered freedom of action. The chief difference between man's dress and woman's is the principle of suspension. The former uses braces, and hangs all the weight on the shoulders, the latter uses corsets, and suspends from the waist. Braces would not do for women—they would cut and pain the delicate flesh of the breasts. Do they suit men? Is it not curious that in all active exercise they are discarded, and a belt substituted? I can easily imagine many inconveniences attending their use; but content myself with suggesting the question. I have said nothing about the grace of men's dress—every one must allow it might be more ornamental. No one who has ever seen a stout, elderly man without his coat can help shuddering at the thought of a matron, stout and elderly, clad in the dual garment, with only a frill round the waistband of the victorious trousers, valuable to the morphologist as showing the course of evolution. Men and women are structurally different in make and physical constitution. I am so benighted as to think their dress should also differ to suit their needs. I could say somewhat in defence of the use (not the abuse) of the abhorred corset; but I prefer begging men to perfect their own costume before attacking the dress worn by one still calling herself

A WOMAN.

THE ABUNDANCE OF GOLD.—The future supply of gold, even for coining purposes, is beginning to be one of more than common interest. Ancient history is resplendent with the prodigal display of gold by the barbaric peoples of the Orient. Arabia, Egypt, and Africa, according to the same authority, were prolific in their production of this precious metal. Pliny states that Cyrus returned from his conquest with 34,000 pounds of gold (about $10,000,000). Alexander the Great brought $100,000,000 in gold from Persia. But at the present time these great fields, so renowned in history, are barren so far as the production of gold is concerned, and it is evident that Europe can be no longer depended upon to perform any appreciable part in furnishing a supply of gold to meet the demands of the future. Even in this country the statistics of production show a constant and marked decline in gold, although the field is largely extended, and mining is more thoroughly prosecuted than ever before.—*Mining Review* (American).

THE REGISTRAR-GENERAL'S ANNUAL SUMMARY.—In the Annual Summary for 1882, just issued by the Registrar-General, in respect to London and other great towns, the number of large towns included in the list of weekly variations has been raised, in accordance with the change made in the beginning of the year, from twenty to twenty-eight. The additional towns are Derby, Birkenhead, Bolton, Blackburn, Preston, Huddersfield, Halifax, and Cardiff. The population dealt with in this return is 9,466,292, or more than one-third of the total for England and Wales. In this population the deaths reached to 205,235, or 21·8 per 1,000, Derby being lowest, with a rate of 18·7, and Preston highest with 27·6 per 1,000; London and Brighton were 21·4 and 21·7 respectively. It is interesting to know that with the exception of the years 1850 (21·0) and 1881 (21·2) the death-rate for last year is the lowest recorded, that for 1872 having exactly equalled it. Of the whole number of deaths 16·3 per cent. or 13,553 were registered as due to zymotic diseases, the aggregate rate thus reaching 3·49 per 1,000. As recorded in the report, the most remarkable fact in this connection was the subsidence of the small-pox outbreak. In 1881, 2,367 deaths took place from this disease, in 1882 only 431. Of these 431 persons who died, 108 were certified to have been vaccinated, 184 unvaccinated, while 139 were doubtful. These figures, therefore, show that, while the deaths among vaccinated persons were 37·0 per cent., of the unvaccinated 63·0 per cent. died.* Another curious point in connection with the same figures is that of the vaccinated 23 per cent. were under 20, and 77 per cent. over 20 years of age; while among the unvaccinated the proportions were nearly reversed, viz., 67·4 and 39·6 per cent. respectively. —*Medical Press.*

* This is incorrectly expressed. The writer means that excluding the doubtful cases 37·0 per cent of those who died were certified to have been vaccinated. As only a small proportion of the population are unvaccinated, the evidence in favour of the protective effects of vaccination is very strong.—R.P.

Editorial Gossip.

A RECENT writer asserts that, according to statistics, dark-haired women have better chances of marrying than their fair-haired sisters. The statistics are not very satisfactory. They show, he tells us, that there are three fair-haired spinsters for two dark-haired ones. To give a meaning to this we should be told at what shade the line is drawn which separates dark from fair; or are only the nearly black-haired considered in one category and the nearly flaxen-haired in the other? Then we need to be told in what proportion, numerically, are the fair and dark women thus classified; for, if there are more fair than dark in a ratio exceeding 3 to 2, the statistics point the other way from that indicated by our author, whereas if the dark are more numerous than the fair, in any ratio, the inference he draws from statistics is strengthened. Yet, even if a relation of this kind should be proved, complexion may have little or nothing to do with the matter. The statistics may, perhaps, show that particular complexions are commonly found in company with such and such temperaments and dispositions; *these*, and not the complexions, may be the attraction chiefly influencing conjugal selection.

IN point of fact, statistics are very seldom dealt with correctly, even by those whose special business it is to analyse and interpret them. Dr. Stark finds that the death-rate among the unmarried is higher than among the married; another finds that crime is more common among the unmarried; madness, also, seems, according to statistics, to visit the single more than the married. So Dr. Stark, and a host of others as hasty in their use of statistics, go about proclaiming that marriage prolongs life, checks crime, and stays the evil course of madness in the blood. It never seems to occur to them that marriage is a selective process, and that, *on the average*, the unhealthy, the criminal, the mentally inferior, have less chance of marrying than their more fortunate brothers and sisters.

IT would matter little if these were mere questions of opinion. But, unfortunately, such statements exert a real and mischievous influence on conduct. Where marriage is arranged or encouraged by parents or guardians, as likely to check the progress of disease—bodily, mental, or moral—the good effects expected may or may not follow, but the reversion of bodily, mental, or moral disease among the offspring is ensured.

NO such harm is perhaps likely to follow from the promulgation of the theory that for a woman to be fair-headed is to have no fair chance of conjugal selection. The theory might cause the fair-headed to dye, perhaps; but that would be balanced by its influence in preventing the dark-haired from seeking such golden dyes as were in favour not so long ago. Still, it is well to have statistics properly dealt with.

SOME of the statistical "facts" brought before the public have as much real truth in them as there was in the well-known saying that statistics prove the railway carriage to be safer than the house. This is really demonstrated by statistics quite as clearly as the theory that "to be unmarried (we quote Dr. Stark) is as fatal as to live in ill-drained houses," or in places where the death-rate is very high. Only, whereas even those who ought to know better are deceived by one statistical fact, no one is quite so foolish as not to see that if more per cent. die at home than in railway carriages (even during excursion times) it is not because of any preservative action in the railway carriage, but because those who are likely soon to die usually stay at home.

THE *Times* has devoted a leading article to the Rational Dress Exhibition, and has taken a very fair and common-sense view of the suggested changes in feminine dress. But because the Rational Dress Reformers carefully refrain from playing their best card, the game is going against them. The most ardent advocates of reform in dress (male or female dress) are likely to be deterred by proposals for changes which attract attention. Women, especially, are not likely to adopt, even for the sake of comfort or health, a dress which would cause them to be stared at. And they are quite right. For, apart from the sense of propriety which leads every right-minded woman to avoid making herself conspicuous, there is the consideration that there is a larger proportion of offensively-staring folk in all classes in this country than in any civilised or semi-civilised community on the face of this earth. Those who would reform dress, then, should devise changes which, though effective, are inconspicuous. They should take a lesson (*fas est ab hoste doceri*) from fashion, which does not hurry women to the successive absurdities in which it rejoices, but guides them gradually from the mania of expanded crinolines to the imbecility of tie-backs, and causes the insanely straight outlines of one era to pass by slow gradations into the wildly serpentine undulations of another. If, for example, the reformers were to watch the progress of the change which is changing fashionably-dressed women to the appearance (especially when walking or turning) of fan-tailed pigeons, and were to strive by slight but progressive changes, each scarcely noticeable, to introdue healthier, lighter, and warmer habiliments, they might do good to thousands for each one whom they can now induce to face the goggle-eyed in obviously divided skirts.

NUMBERS of letters reach me because of a letter I wrote to the *Times*, showing how much good might be done without any discernible change at all, and numbers of comments, chiefly sensible—but some foolish—have appeared in the papers. Among the less sensible comments are those dwelling on the courage required to change the costume to the extent mentioned in my letter; for I was careful to explain that I referred to a compromise already described in the *Times* leader—a change of dress absolutely unnoticeable even by feminine eyes.

THE *Standard*, illogically enough, remarks that ladies were able to walk, play tennis, sing, dance, and so forth, before divided skirts were thought of. What has this to do with the fact that many ladies, having tried the experiment, find they can do all these things better, and with more pleasure to themselves, after a quite undiscernible change of attire, than they could before? The *Dublin Mail* makes some reference to the propriety of the subject for discussion, on which I would only remark that any one who finds impropriety in the subject must belong to the class which Charles Reade has dealt with in a well-known letter on "The Prurient Prude."

IN several of these communications the ladies mentioned in my letter to the *Times* are identified as my daughters,

my sisters, my wife and daughters, and so forth. It has so chanced that not one of these shots has been quite right. I may be permitted to suggest to these anonymous scribes that there is a considerable range for choice among relationships corresponding with what I wrote. Thus (merely to begin), there are sisters, daughters, nieces, cousins in the first, second, and third degree, wife, mother, aunts; wife's sisters, cousins, nieces, aunts; brother's wife, *her* sisters, cousins, &c.; there might be the sisters, cousins, nieces, &c., of a first or second wife, or of a wife's first or second husband, and so there might be step-daughters, brother-in-law's sisters, cousins, aunts, and so forth; or, again, there might be none of these.

MR. PROCTOR has just closed a very successful course of six lectures at the Royal Concert Hall, St. Leonard's, at which more than 1,000 persons have been present. Two lectures have also been given at the Pavilion, Eastbourne, and these are the first of a series which, during the summer season, will be continued at Brighton, Tunbridge Wells, Lewes, Worthing, and elsewhere. The experiment is as bold as that recently completed with such gratifying results at St. James's Hall, and there is every indication of even greater success. The arrangements of the lecture tour are in the hands of Mr. John Stuart, of St. Leonard's.

AMONG the most interesting features of the Zoological Gardens (Philadelphia) are the peculiar relations existing between the capybara and two pretty kittens. The capybara (*Hydrochærus capybara*) is a curious creature. It is the largest of rodents, and in its habits and characteristics very much resembles our musk-rat. It lives in the water and burrows in the banks of the South American rivers. It is about as large as a big dog, and is covered with coarse hair. As it lies in the pen in the deer-house it is continually accompanied by the two kittens. Sometimes he will play with them and poke them about with his nose: thereupon they will mount his back and sit serenely, while he is unable to get them off. Then he will plunge into his water tank, and water-hating tabby will spring off to escape the undesired bath. If the cats leave the pen, "Porgy" (he is so called after "Porgy" O'Brien, the circus man) will follow them to the bars and make a funny squeaking noise, beseeching his companions to come back to keep him company. Sometimes the keepers will bother the kittens. They fly at once to the protecting sides of "Porgy," while he will bare his long teeth and chatter fiercely. In the next cage is a wallaby, and while the cats go in and out, they do not attempt to be at all friendly. They confine their allegiance wholly to the more ugly capybara.—*Philadelphia Press.*

MID-OCEAN TELEGRAPHY.—The following, taken from a contemporary, is given for what it may be worth:—The idea of telegraphing from ships at sea is not a new one, and crops up from time to time. Mid-ocean telegraph stations have been proposed, and will, probably, be carried out some day. The chief difficulty in the way of their adoption has hitherto been the necessity of keeping the ship connected by a branch cable to the main cable lying on the bottom, and anchoring her so as to maintain this communication in all weathers and depths desirable. But Professor A. E. Dolbear has proposed a plan which may render this fixed communication unnecessary. A large metal plate attached to an insulated conductor is lowered from the ship to the bottom on the track of the cable, and another plate is merely submerged. Between these two plates a battery and Morse key is inserted. On working the key the Morse currents induce other currents in the cable, which can be heard in telephones attached to the cable on shore.

"Let Knowledge grow from more to more."—ALFRED TENNYSON.

Letters to the Editor.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the EDITOR OF KNOWLEDGE; *all Business communications to the* PUBLISHERS, *at the Office, 74, Great Queen-street, W.C.* IF THIS IS NOT ATTENDED TO, DELAYS ARISE FOR WHICH THE EDITOR IS NOT RESPONSIBLE.

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JOSHUA AND THE SUN.

[837]—I beg to refer any reader of Letter 798 (April 27) to 688 (Jan. 9), the sole mention yet made of Jacob Bryant, to see what grounds there are for saying I "quote Bryant as an authority." I named him as having "fully convinced me." What has convincing to do with authority? But let none who may turn to his arguments fancy there are no better. He was ignorant that the book the Samaritans call "Joshua," which is now thrice as long as ours, but about twice if we omit everything after Joshua's time, while quite agreeing in most details, and specially those of the Gideon battle, and thunderstorm and hail, has not a word of the sun or moon. If we must come to "authority," here is probably the earliest extant—certainly, as all admit, much older than the LXX. As for these translators (who were never a bit more authority than our "James, King of France's"), of course, they adjusted it to the vulgar creed of their time, with no more criticism than Habakkuk (iii. 11) or the son of Sirach (xlvi. 5, 6). But even the blindest retailers of pulpit-stuff to-day, who say (see Barrett's "Synopsis of Criticism") "that the sun and moon did really stand still, is proved by" the above texts!—are puzzled enough by Joshua's speech having nothing about standing still. "*Sun on Gibeon, be dumb,*" was the best even Dr. Adam Clarke could make of it. Very odd that the Power able to make the sun stand "still in the midst of heaven" should inspire nobody to mention aught nearer to "stand still" than "be dumb," or nearer "the midst of heaven" than Gibeon! Then the topographers all agree that Ajalon was so much west of Gibeon that, for the moon to be seen at all, the miracle must have been in the *morning*, and "hasted not to go down about a whole day," was exactly what the sun would naturally not haste to do. The only miracle would have been not hasting *up* towards the meridian. But in what tribe, however savage, is a general childish enough to connect the heavenly bodies thus with neighbouring spots?

Poor Josephus was nearly nonplussed here. After far more about the thunder and hail, by which Joshua "believed that God assisted him," he manages to compress the whole day phenomenon into a line, and without mention of sun, moon, God, miracle, or that most glaring inconsistency that "they were more which died with hailstones than they whom the children of Israel slew with the sword." (Did the chief executioners, the hailstones, need more daylight, then?) Carefully sinking this, he proceeds: "It happened, too, that the day was lengthened, that the night might not come on too soon." (Quite a piece of luck, you see, like snow at Charles I.'s funeral. Afterwards he adds, "That the day was really lengthened at that time, and was longer than usual, is stated in the books that were kept in the Temple."

Now, the first mention of a book being laid up in the Temple—or rather Tabernacle—was on the anointing of Saul (1 Sam. x. 25): "Then Samuel told the people the manner of the kingdom, and wrote it in a book, and laid it up before the Lord." This book, as Sir Isaac Newton showed, must have included the first, and probably the first seven, of the present Bible. It included Genesis, which, in its chap. xxxvi., brings down Edomite history to that same generation, and professes not to be edited till there was a king in Israel (ver. 31). And the seventh, Judges, dates itself, at its ver. 21, as completed while the Jebusites yet held Jerusalem, of which

they were dispossessed in David's eighth year (2 Sam. v. 4); so that the whole seven books vigorously limit their composition within forty-seven years, if Saul reigned forty (as stated in the New Testament and best copies of Josephus). But Joshua's time was then as distant as the Wars of the Roses are from us.

The total silence of the New Testament as to the sun miracle, especially that of the writer to the Hebrews (xi.) is most signal and decisive; and hardly less notable is that of Philo, who had many occasions for allusion to it. There is a very apocryphal book (which Whiston, however, thought genuine) called the "Eighteen Psalms of Solomon." It ends with this remark on the heavenly bodies:—"They have not erred, from the day that He created them; they have not left their way, from ancient generations; except when God enjoined them by the command of His servants." Now Philo, in his voluminous works, often insisted on this constancy of celestial motions; and notably in his two "Dialogues on Providence," almost verbally repeats the above, but without a hint at any exception. E. L. GARBETT.

P.S. In letter 688, second paragraph, the five repetitions of "p.m.," partly right and partly wrong, are the printer's fancy, as I only spoke of eleven and one o'clock.

PROBLEM IN CHANCES.

[838]—I beg to enclose the following answer to "A. M. T.'s' question [818], which appeared in KNOWLEDGE of May 18.

If the probability of a person naming the winner in any given race is $\frac{1}{5}$, what is the probability that he will name *exactly* six winners out of ten races?

The probability that he would be right in *any particular* six races, and wrong in the other four (*e.g.*, that he would be right in the first six and wrong in the next four), is

$$\left(\frac{1}{5}\right)^6\left(\frac{4}{5}\right)^4 \text{ or } \frac{4^4}{5^{10}}$$

But anybody would gain the prize who named the winners in *any* six races.

And by elementary algebra the number of different groups of six which can be obtained out of ten races is

$$\frac{10.9.8.7.6.5}{6.5.4.3.2.1} \text{ or } \frac{\lfloor 10}{\lfloor 6 \,\lfloor 4}$$

Hence the probability of naming *exactly* six winners in ten races is $\frac{\lfloor 10}{\lfloor 6 \,\lfloor 4} \cdot \frac{4^4}{5^{10}}$, which is the fifth term in the expansion of the binomial $\left(\frac{1}{5}+\frac{4}{5}\right)^{10}$, and is equal to $210\,\frac{4^4}{5^{10}}$. The probability of naming at least six winners is

$$\frac{1}{5^{10}}+10\frac{4}{5^{10}}+\frac{\lfloor 10}{\lfloor 8 \,\lfloor 2}\frac{4^3}{5^{10}}+\frac{\lfloor 10}{\lfloor 7 \,\lfloor 3}\frac{4^3}{5^{10}}+\frac{\lfloor 10}{\lfloor 6 \,\lfloor 4}\frac{4^4}{5^{10}}$$

A. M. M.

LETTERS RECEIVED AND SHORT ANSWERS.

ONE OPEN TO CONVICTION. Considering that a series of articles on "Intelligence in Animals" appeared in the first volume of KNOWLEDGE, in which the view you think so unreasonable was advocated on the strength of rather striking evidence, you must not be surprised to find that I take a different view.—J. DE GALINDEZ. Your solution of the chance problem is not correct. You are "firm as a rock" in a wrong conviction. Rocks may be rent. As to the other problem, your verbal statement of it does not agree with the solution. It presents no features of interest, so far as I can see.—W. G. GREENER. Regret, but am quite unable to answer through the post. Such letters reach me by hundreds.—FACIEBAT. Return the letter. Cannot say my experience of those who write about language leads me very much to admire their way of writing. I doubt if they are the best judges. When the "author of a primer" tells the author of forty books how to write English, the latter is apt to feel somewhat as Charles Lamb did when a schoolmaster offered to teach him the system by which the boys of his establishment were trained in composition. Your friend seeking to show how a certain sentence should be worded, suggests a form which would not have suited me at all—putting "which, however," for "but which." "But which" and "and which," as ordinarily met with are nine times out ten incorrect; in the tenth case the form is absolutely essential to the sense, and the expression only seems clumsy to those who have had to give so much time to correcting the wrong use of the expression—in school exercises, and so forth—that they cannot bear to hear it at all. I take the sentence you object to, and try the effect (1) of removing "but," (2) of substituting "it" for "which," and (3) "which, however," for "but which." In every case it fails to express my meaning. As written it *does* express my meaning, and it is grammatically sound, noting that there is an ellipsis, permissible in a sentence which is meant to be a title, and is therefore reasonably presented in an abridged form. Your criticism, and your friend's, reminds me of one which a friend of mine made on a sentence in this form:—"If a colony of Englishmen were removed to India, and there left without interference, all would have died out at the end of two hundred years." My friend insisted that either for "were" should be substituted "had been," or for "would have died" should be substituted "would die" or "would be dead"; because he had the scholastic idea that tenses must be balanced. I objected, because I wanted to say what I had said, and not what the balancing of tenses would have made me say—in other words, I wanted to indicate, not only the state of things at the end of a certain interval, but the progress of events to that end. The professed language-analyser, however, will always prefer well-balanced words, tenses, &c., to so paltry a consideration as the mere meaning a writer wishes to convey.—AN INQUIRER AFTER TRUTH. The narrative literally interpreted is, of course, absurd. What the real interpretation may be, who can guess?—W. HUME. Agree with you; but it is hardly worth while to have any correspondence about the matter. Any man who suffers under the chimney pot for the sake of appearances—*may* suffer. A fellow of that sort might wear a comfortable head-covering, and hold a new hat in the hand, or sling it over the shoulders, or in some other way avoid the distressing suggestion that he could not afford a tall hat.—JUVENIS. Cannot make the "hare and tortoise" matter clearer, nor answer queries such as elementary textbooks deal with. As a mere detail, the earth's axis does *not* always point to the same star.—E. C. H. Yes, we mistook; however the question has now been sufficiently answered.—H. P. Any elementary treatise on rigid dynamics will show you how to calculate moments of inertia, and unless you have studied such, any explanation we could give would be of no service to you.—ONE WHO KNOWS. As you suggest, that could hardly be discussed here.—W. R. Darwin certainly does not draw any definite line between varieties and species. How could he, with his views as to the origin of species? Quatrefages' other objection is absurd. One might as reasonably say that the gradual addition of a blue liquid to a red one would never produce a purple liquid, because the various tints resulting from greater or less admixture of blue and red would produce "the greatest confusion." A race which, owing to changes of condition, is undergoing a change of character with the progress of time, does not break up into a number of races, but changes, as a whole, its progress in any direction being measured by the average condition of individual members of the race in regard to the changing characteristics. The constant crossing has not the effect imagined by Quatrefages, but an effect akin to the constant intermixing of the different portions of a liquid which is undergoing change of tint.—WALT. PILGRIM. Oh, favour us with an interval of repose.—H. ROMEITCE. You think *I* may have no reason to complain of adverse criticism, because such criticisms, if they appeared, would not be sent to me. My dear sir, ages before your "Artistic and Literary Correspondence" was established, an institution existed which ensured that at least every adverse criticism should reach its mark; the institution is called "the good-natured friend," to which some add, after Sheridan, a strong theological participle. Any one who pays you five shillings for twenty adverse criticisms, every one of which would be sure to reach him through the D. G. F., must have many shillings to waste, and a singular taste "at that," as your country folk put it.—H. MALIM. Neither solution is correct, as you will presently see.

Our Mathematical Column.

GEOMETRICAL PROBLEMS.

By RICHARD A. PROCTOR.

INTRODUCTION.

THE object of these hints to the solution of geometrical problems, is to show the student how he should deal with deductions which are proposed to him in examination. There are many books in which sets of problems are given, with several fully solved, and hints supplied for the solution of others; but these are often of little use to the student. The average mathematical student requires to learn—*not* how to solve this or that problem, *nor* what construction will help him in any particular case—*but* what are the

general methods which he must apply to problems in order to obtain solutions for himself. The mathematical teacher who simply solves the problems brought to him by his pupils does little to show how such problems are to be treated. He should exhibit to his pupils the train of thought which leads him to apply such and such processes to the solution of a problem. And more than this—a good tutor will show his pupils where they might be led astray by imperfect methods; he will try the effects of steps which he himself knows to be bad, and thus show his pupils what methods to avoid as well as what methods to apply. One problem thus dealt with is worth a dozen which are merely solved; and I believe the student who will carefully go through the examples which I shall take to pieces (so to speak) in the following series, will learn more than he would from seeing any number of problems merely solved.

Geometrical Deductions.

Geometrical deductions are problems which are intended to be solved by the application of recognised geometrical methods and propositions. They are divided into several classes.

A geometrical deduction is termed a *rider* when it is given as an exercise on a particular proposition. It generally happens that the difficulty of a deduction is greatly diminished when it is given in this way, for we know in what direction to seek for a solution. When a deduction is presented as a rider, it is, of course, expected that the proposition to which the deduction is appended shall be made use of in the solution. It will occasionally happen, with carelessly-constructed riders, that a simpler solution, not involving this proposition, is available; but generally there can be no difficulty in so arranging the proof as to introduce the proposition on which the deduction is supposed to be founded.

A deduction may be given as an exercise on a particular book of Euclid, or on a given set of propositions. In such a case, it is of course expected that no later books or propositions (as the case may be) shall be made use of.

Or, a deduction may be given as an exercise on Euclid, generally—in which case it is expected that no *methods* which are not used by Euclid shall be applied to the solution of the problem, and, further, that no proposition not contained in Euclid, or not readily deducible from Euclid's propositions, shall be made use of.

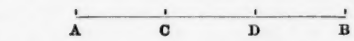
Lastly, there are deductions of a more advanced character, and propositions which present themselves in the solution of problems in other subjects, such as trigonometry, optics, mechanics, and so on. In treating deductions of this sort, it is allowable to make use of several well-known geometrical problems not established by Euclid, nor obviously deducible (that is, deducible as *corollaries*) from his propositions. Hence these properties may themselves be presented as exercises on Euclid—and, in fact, most of them will be found in collections of deductions. It seems better, however, to direct the student's attention specially to propositions of this sort, since their importance is apt to be lost sight of when they are included in a long list of deductions. It is possible that I may on some future occasion attempt to gather together all those propositions which may fairly be looked on as subsidiary. Some of them are very simple, others less so; but the student should have all of them at his fingers' ends, since they are of continual service in geometrical processes.

Construction.

The first step in the solution of a geometrical problem is the construction of a figure which shall afford a clear conception of what we have to do or prove. There are some who insist that no one deserves to be called a geometrician who makes use of well-drawn figures. To solve a difficult problem when the illustrative figure is unlettered, or when ovals are drawn for circles, waved lines for straight ones, and so on, may be all very well for the advanced mathematician. Indeed, a good geometrician should be able to take up a list of problems and solve the major part without pen or paper. But it seems to me a great mistake to insist that the learner should increase the difficulties he naturally has to encounter, by making difficulties for himself. And independently of this consideration, there is nothing better calculated to lead the student to observe new properties—or properties new to him—than the construction of a well-drawn figure. He is led to notice relations which would otherwise escape him. Thence he learns to seek for the proof of such relations, to satisfy himself that they are real—not apparent. And it is this habit of being always on the watch for new properties which serves as the most efficient aid in the solution of geometrical problems, and which, also, so far as mathematical progress is concerned, is the most valuable fruit of geometrical studies.

The beginner should even use mathematical instruments, and should spare no pains in the exact construction of his figures. But after awhile, all that will be necessary is that the figures should be drawn, free-hand, so as to represent as closely as possible the relations described in the proposition to be investigated. Simple as this seems to be, there are a few points which deserve to be attended to. A few illustrations will serve better than formal rules:—*

Suppose a problem spoke of a trisected line: the student would probably draw a line, as A B, Fig. 1, and then divide it as nearly as possible into three equal parts, in C and D. This is not the best plan: he should draw a line, as A D, bisect it as nearly as possible



in C, and then produce it to B, so that D B may be as nearly equal to D C as possible. He will thus have a line much more exactly trisected than by the former method, since every one can bisect a line, or produce it till the part produced is equal to the adjacent part, whereas many fail in the attempt to trisect a line. Similar remarks apply to the division of a line into five, seven, or nine equal parts.

(To be continued.)

Our Chess Column.

By Mephisto.

THE TOURNAMENT.

SCORE UP TO TUESDAY NIGHT.

	Bird	Blackburne	English	Mackenzie	Mason	Mortimer	Noa	Rosenthal	Sellman	Skipworth	Steinitz	Tschigorin	Winawer	Zukertort	Draws not counting	Total score
Bird	—	1	1	1	0	1	0	0	1	1	00	0	1	00	5	7
Blackburne	0	—	1	0	1	1	1	1	1	11	1	0	½	0	7	9½
English	0	0	—	½	0	1	1		1	1	1	1	0	00	0	6½
Mackenzie	0	1	½	—	0	1	1	0	½	1	0	0	0	0	9	5
Mason	1	0	1	1	—	1	½	1	1	1	0	1	1	0	10	9½
Mortimer	0	0	0	0	0	—	0	0	00	01	0	0	0	0	3	1
Noa	1	0	0	0	½	1	—	10	0	0	0	01	0	0	5	4½
Rosenthal	1	0		1	0	1	01	—	0	1	1	1	½	0	11	7½
Sellman	0	0	0	½	0	11	1	1	—	0	0	0	0	0	6	4½
Skipworth	0	00	0	0	0	10	1	0	1	—	0	0	0	0	2	3
Steinitz	11	0	0	1	1	1	1	0	1	1	—	0	1	1	2	10
Tschigorin	1	1	0	1	0	1	10	0	1	1	1	—	10	0	2	9
Winawer	0	½	1	1	0	1	1	½	1	1	0	0	—	0	9	8
Zukertort	11	1	11	1	1	1	1	1	1	1	0	1	1	—	4	14

There was no fresh play last week, as it was deemed desirable to allow the players to decide their drawn battles. The beginning of the second round was, therefore, postponed to Monday, the 28th inst. Of the games which came to a decisive conclusion, the contest between English and Mason proved doubly interesting, as in the first instance it was a very well-fought game, as may be seen from its perusal; secondly, it was a success gained by a likely candidate for high honours. Mason by this victory passed Steinitz and Tschigorin, coming out second. In spite of the time granted, there yet remains one draw to be played off between Rosenthal and English, either of whom may yet slightly improve their position by winning.

The score of the players before the beginning of the second round stood as follows:—

Zukertort	12	English	6½
Mason	9½	Rosenthal	6½
Steinitz	9	Mackenzie	5
Tschigorin	9	Noa	3½
Blackburne	8½	Sellman	3½
Bird	7	Skipworth	3
Winawer	7	Mortimer	0

* Some of the matters here treated of may seem trivial, but in examinations they will be found not unimportant. It must, indeed, be remembered that these papers have special reference to the requirements of young mathematicians preparing for examination.

XUM

Another most forcible conclusion as to the chances in Tournament play may be drawn by a comparison of Dr. Noa's play in London and Vienna. At the latter place, after the conclusion of the first round, he stood at 9 against Zukertort's 9½, a most glaring contrast to his present score. He has, however, also in London proved himself a player of considerable power, as he drew all his three games with Mason.

On Monday the second round was commenced. The result was that English drew with Steinitz, as did also Blackburne and Mason, Mackenzie and Sellman, Winawer and Rosenthal, Noa beat Tschigorin, Mortimer beat Skipworth. The game between Bird and Zukertort was adjourned after 9 hours play.

On Tuesday Zukertort beat English, he also later on won his adjourned game with Bird. Rosenthal beat Noa, Blackburne beat Skipworth, Steinitz beat Bird, Winawer beat Tschigorin, Sellman beat Mortimer, Mason and Mackenzie drew.

In the second tournament Bardeleben stands best for first prize with a score of 19½ out of 22. Fisher has the second prize certain with a score of 20½ out of 25, which is the full number of games to be played. Gunsberg has scored 17 out of a total of 22, while Macdonald stands at 19½ out of 25.

GAME BETWEEN ENGLISH AND MASON.

QUEEN'S GAMBIT DECLINED.

White. English.	Black. Mason.	White. English.	Black. Mason.
1. P to Q4	P to Q4	26. P to QR4	P to QB4
2. P to QB4 (*a*)	P to K3	27. P to R5	R at Q3 to QB3
3. Kt to QB3	B to Kt5	28. RP takes P	RP takes P
4. P to K3	Kt to KB3	29. P takes P	P takes P
5. Q to Kt3 (*b*)	Kt to B3	30. R to B4	K to B2 (*l*)
6. Kt to B3	Q to K2	31. B to Kt2	Kt to Q3
7. P to QR3	B takes Kt	32. R to KB4	R to QR3
8. Q takes B	Castles (*c*)	33. R to Q sq.	R at B sq. to B3
9. B to Q3	P takes P	34. P to K4	R to QR5
10. Q takes P	P to K4	35. P to KKt3	Kt takes KP
11. P takes P	Kt takes P	36. R to Q7 (ch)	K to K sq. (*m*)
12. Kt takes Kt	Q takes Kt	37. R takes P	R to Kt3
13. Castles	B to K3	38. R at Kt7 to Kt4	R at Kt3 to Kt5
14. Q to B2	KR to Qsq ((*d*)	39. B to B sq.	P to KR4
15. P to B4 (*e*)	Q to Q4	40. R to R4	K to Q2 (*n*)
16. B to K2	P to B3	41. R to B sq.	Kt to QB6
17. P to QKt4 (*f*)	B to B4	42. R takes P (*o*)	Kt to K7 (ch.)
18. Q to R2 (*g*)	Q takes Q	43. K to B2	R to R7
19. R takes Q	B to Q6 (*h*)	44. R to R7 (ch.)	K to B3
20. B to QKt2(*i*)	Kt to K5	45. B to K3	R to Kt6
21. B to Q4	B takes B	46. K to B3	Kt to Q5 (ch.)
22. R takes B	P to QKt3 (*j*)	47. K to B4	R to R5
23. R to QB2	QR. to QB sq.	48. R to K7	Kt to QB7 (dis. ch.)
24. P to B5 (*k*)	P to B3		
25. KR to B sq.	R to Q3	49. K to B3	QR to R6 wins

NOTES.

(*a*) We prefer 2. Kt to KB3, which leads to a more modern and safe Queen's side opening.

(*b*) Not much to be said in its favour—it loses time.

(*c*) Black having Castled, and both his Knights well posted on B3, has already a considerable advantage of position.

(*d*) Now comes that heavy and subtle wrestling for position which distinguishes the first-class player. A study of the position will reveal its difficulties. The black Queen keeps White's QB confined, he also threatens Kt to Kt5. 15. P to K4, an otherwise promising-looking move, Black would reply with R to Q2, afterwards doubling the Rooks.

(*e*) This displaces the Queen, but it creates a new weakness in White's centre.

(*f*) With the hope of developing his QB.

(*g*) White thinks to relieve his game by exchanging, while Black considers his position good enough to venture upon that step without fear of drawing.

(*h*) Another high-pressure move; if B takes B, Black gets his Rook into good play.

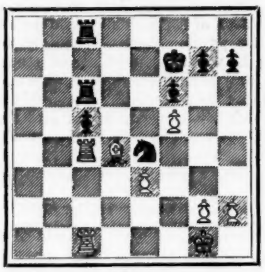
(*i*) If Black plays B takes B then 21. B takes Kt would probably lead to a draw.

(*j*) Black now devotes his attention to advancing his QBP.

(*k*) This advance weakens the Pawn.

(*l*) Black vigorously pursues his advantage in position. We give a diagram after Black's 30th move, K to B2.

ENGLISH.
BLACK.



WHITE.
MASON.

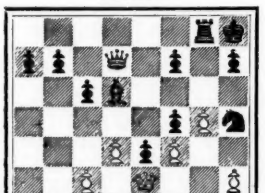
(*m*) Very well played. White can only capture the Pawn at great risk to himself from Black's Rooks.

(*n*) Black gradually increases his attack, while White's Rooks have got out of play. White dare not take the RP, as Black threatens R to R8, followed on the White R to B sq. by the other Rook to Kt8 to win the B.

(*o*) A fatal capture, from this point Black finishes off in masterly style.

POSITION AFTER BLACK'S 26TH MOVE, KT. TO R4, IN A GAME PLAYED ON THE 28TH INST.

NOA.
BLACK.



WHITE.
TSCHIGORIN.

White. Tschigorin.	Black. Noa.	White. Tschgorin.	Black. Noa.
27. P to B4	P to B3	35. Kt takes Kt	Q to R7 (ch) !
28. P to KR4	P to KR3	36. K to K sq.	B takes Kt
28. Q to KR3	RP takes P	37. R. takes B	P to Kt7 !
29. RP takes P	Q to R2	38. R to B2	P to Kt8 (Q) (ch)
30. K to Kt sq.	P takes P	39. K to K2	Q (Kt8) takes R (ch)
31. K to B2	P to Kt5		
32. Q to K3	P to Kt6 (ch)	40. Q takes Q	R to Kt7, and Black won.
33. K to K2	R to Kt5		
34. P to B5	Kt takes P (ch)		

NOTICES.

Just Published, Part XIX. (May, 1883). Price 10d.; postage 3d. extra.

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The terms of Annual Subscription to the weekly numbers of KNOWLEDGE are as follows:—

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P. O. Orders and cheques should be made payable to the Publishers, MESSRS. WYMAN & SONS, London, at the High Holborn District Post-office.

Agent for America—C. S. Carter, American Literary Bureau, Tribune Buildings, New York, to whom subscriptions can be forwarded.

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